CLAIMS

1. A communications system comprising:

a first node having a first oscillator for sending multiple messages over a network and including or associating with each message a first timestamp corresponding to a time when the first node sent that message, and

a second node having a second oscillator for receiving each message and including or associating with that message a second timestamp corresponding to a time when the second node received that message,

wherein one of the first and second nodes is configured to determine for each message a first time difference between the corresponding first and second timestamps, and from multiple first time differences, to fit a line to two or more minimum delay values of the first time differences, a characteristic of the line being related to a frequency drift between the first and second oscillators,

wherein the one node is configured to determine from the line a frequency adjustment to synchronize the first and second oscillators.

2. The system in claim 1, wherein the first node is configured to adjust the first oscillator using the frequency adjustment.

3. The system in claim 1, wherein the first node is configured to send a message to the second node to adjust the second oscillator using the frequency adjustment.

4. The system in claim 1, wherein the one node is the second node configured to adjust the second oscillator using the frequency adjustment.

5. The system in claim 1, further comprising:

plural second nodes,

wherein the first node and the second nodes are configured so that the first node synchronizes the second nodes by broadcasting the frequency adjustment to the second nodes.

6. The system in claim 1, wherein the one node is the first node configured to send a message to the second node that includes the frequency adjustment for adjusting the second oscillator.

7. The system in claim 1, wherein the first node is a timeserver and the second node is a client node and the messages are transported over a packet-switched network.

8. The system in claim 1, wherein the system is a mobile communications system, the first node is a radio network controller, and the second node is a radio base station.

9. The system in claim 1, wherein the system is a mobile communications system, the first node is a radio base station, and the second node is a radio network controller.

10. The system in claim 9, wherein the messages between the radio base station and the radio network controller are packet-switched.

11. The system in claim 1, wherein the characteristic of the line is a slope $\rho$ of the line.

12. The system in claim 11, wherein the one node is configured to adjust the second oscillator by a factor of $1-\rho$.

13. The system in claim 1, wherein the one node is configured to determine an equation of a line that intersects the two minimum first time difference values.

14. The system in claim 13, wherein the one node is configured to determine the two minimum first time difference values from the multiple time differences that are farthest apart.

15. The system in claim 1, wherein the one node is configured to determine an optimal number of minimum values of the first time differences to be used in fitting the line.

16. The system in claim 15, wherein the one node is configured to divide the first time differences into an optimal number of time slots, determine a minimum time

difference value for each time interval, and fit the line to intersect a minimum time difference value for each time interval.

17. The system in claim 16, wherein the one node is configured to determine a minimum number of time difference values for each time interval.

18. A communications system comprising:

a first node having a first oscillator and a first timer for sending messages over a network and including or associating with each message a first timestamp corresponding to a time when the first node sent that message, and

a second node having a second oscillator and a second timer for receiving each message and including or associating with that message a second timestamp corresponding to a time when the second node received that message and a third timestamp corresponding to a time when the second node sends that message back to the first node,

wherein the first node is configured to include or associate with each received message a fourth timestamp corresponding to a time when the first node received that message,

wherein one of the first and second nodes is configured to determine for each received message a first time difference between the corresponding first and second timestamps and a second time difference between the corresponding third and fourth timestamps, and from multiple sets of first and second time differences, to determine a minimum first time difference and a minimum second time difference, and

wherein the one node is configured to determine from one or both of the minimum first and second time differences one or both of (1) a frequency adjustment to synchronize the first and second oscillators and (2) a time adjustment to synchronize the first and second timers.

19. The system in claim 18, wherein the first node is configured to adjust the first oscillator to be synchronized with the second oscillator.

20. The system in claim 18, wherein the first node is configured to adjust the first timer to be synchronized with the second timer.

21. The system in claim 18, wherein the first node is configured to send an adjustment message to the second node to adjust one or both of the second oscillator and the second timer.

22. The system in claim 21, further comprising:

plural second nodes,

wherein the first node and the second nodes are configured so that the first node synchronizes the second nodes by broadcasting the adjustment message to the second nodes.

23. The system in claim 18, wherein the first node is a client node and the second node is a timeserver node and the messages are transported over a packet-switched network.

24. The system in claim 18, wherein the system is a mobile radio communications system, the first node is radio base station, and the second node is a radio network controller.

25. The system in claim 18, wherein the system is a mobile radio communications system, the first node is radio network controller, and the second node is a radio base station.

26. The system in claim 24 or 25, wherein the messages between the radio base station and the radio network controller are packet-switched.

27. The system in claim 18, wherein the first node is configured to determine two minimum first time differences that are farthest apart in the multiple sets of first time differences and two minimum second time differences that are farthest apart in the multiple sets of second time differences.

28. The system in claim 27, wherein the one node is configured to determine a first line that fits the two minimum first time differences and a second line that fits the two minimum second time differences, and from the first and second lines, to determine one or both of the frequency adjustment and the time adjustment.

29. The system in claim 28, wherein the one node is configured to determine an equation of each of the first and second lines and to use a first slope and a first

vertical axis intercept of the first line and a second slope and a second vertical axis intercept of the second line to determine one or both of the frequency adjustment and the time adjustment.

30. The system in claim 29, wherein the one node is configured to determine whether the first slope and the second slope have approximately the same magnitude and whether one of the first and second slopes is positive and the other is negative.

31. The system in claim 18, wherein the one node is configured to determine an optimal number of minimum values of the first time differences to be used in fitting the line to the multiple values of the first time differences.

32. The system in claim 31, wherein the one node is configured to divide multiple values of the first time differences into an optimal number of time slots and determine minimum time difference values for each time interval and fit the line to intersect a minimum time difference value for each time interval.

33. The system in claim 32, wherein the one node is configured to determine a minimum number of time difference values for each time interval.

34. A method for use in a communications system including a first node having a first oscillator and a second node having a second oscillator, comprising:

the first node sending multiple messages over a network and including or associating with each message a first timestamp corresponding to a time when the first node sent that message;

the second node receiving each message and including or associating with that message a second timestamp corresponding to a time when the second node received that message;

determining for each message a first time difference between the corresponding first and second timestamps, and from multiple first time differences, fitting a line to two or more minimum values of the first time differences, a characteristic of the line being related to a frequency drift between the first and second oscillators; and

determining from the line a frequency adjustment to synchronize the first and second oscillators.

35. The method in claim 34, wherein the characteristic of the line is a slope $\rho$ of the line.

36. The method in claim 35, wherein the frequency adjustment is related to $(1-\rho)$.

37. The method in claim 34, wherein the second node adjusts the second oscillator using the frequency adjustment.

38. The method in claim 34, wherein the first node sends a message to the second node that includes the frequency adjustment for adjusting the second oscillator.

39. The method in claim 38, wherein the communications system includes plural second nodes and the first node synchronizes the second nodes by broadcasting the frequency adjustment message to the second nodes.

40. The method in claim 34, further comprising:

determining an equation of a line that intersects the two minimum time difference values.

41. The method in claim 40, further comprising:

determining the two minimum time difference values that are farthest apart.

42. The method in claim 34, further comprising:

determining an optimal number of minimum values of the first time differences to be used in fitting the line.

43. The method in claim 42, further comprising:

dividing multiple values of the first time differences into an optimal number of time slots;

determining a minimum time difference value for each time interval; and

fitting the line to intersect a minimum time difference value for each time interval.

44. The method in claim 43, further comprising:

determining a minimum number of time difference values for each time interval.

45. The method in claim 34, wherein the first node is a timeserver and the second node is a client node and the messages are transported over a packet-switched network.

46. The method in claim 34, wherein the system is a mobile communications system, the first node is a radio network controller, and the second node is a radio base station.

47. The method in claim 34, wherein the system is a mobile communications system, the first node is a radio base station, the second node is a radio network controller, and wherein the messages between the radio base station and the radio network controller are packet-switched.

48. The method in claim 34, wherein the first node includes a first timer and the second node includes a second timer, the method further comprising:

the second node includes or associates with the message a third timestamp corresponding to a time when the second node sends that message back to the first node;

the first node includes or associates with each received message a fourth timestamp corresponding to a time when the first node received that message;

determining for each received message a first time difference between the corresponding first and second timestamps and a second time difference between the corresponding third and fourth timestamps, and from multiple sets of first and second time differences, determining a minimum first time difference and a minimum second time difference; and

determining from one or both of the minimum first and second time differences one or both of (1) a frequency adjustment to synchronize the first and second oscillators and (2) a time adjustment to synchronize the first and second timers.

49. The method in claim 45, further comprising:

determining a first line that fits the multiple sets of first time differences and a second line that fits the multiple sets of second time differences, and

from the first and second lines, determining one or both of the frequency adjustment and the time adjustment.

50. The method in claim 49, wherein the communications system includes plural second nodes, the method further comprising:

the first node broadcasting one or both of the frequency adjustment and the time adjustment to the second nodes.

51. The method in claim 49, wherein the first and second lines are fit to the first and second sets of time differences by identifying at least two minimum time difference points for each set and determining an equation of a line that intersects the two minimum delay time difference points.

52. The method in claim 51, wherein the two minimum time difference points farthest apart in each of the first and second sets are determined

53. The method in claim 49, further comprising:

using a first slope and a first vertical axis intercept of the first line and a second slope and a second vertical axis intercept of the second line to determine the first and second minimum time differences.

54. The method in claim 53, further comprising:

determining whether the first slope and the second slope have approximately the same magnitude and whether one of the first and second slopes is positive and the other is negative.

55. A node for use in a communications system, comprising:

a first oscillator;

a controller for receiving multiple messages from another node over a network, each message having a first timestamp corresponding to a time when the first node sent that message, and for including or associating with that message a second timestamp corresponding to a time when the second node received that message,

wherein the controller is configured to (1) determine for each message a first time difference between the corresponding first and second timestamps, and from multiple first time differences, fit a line to two or more minimum values of the first time differences, a characteristic of the line being related to a frequency drift between the first and second oscillators, and (2) determine from the line a frequency adjustment to synchronize the first oscillator with a second oscillator in the other node.

56. The node in claim 55, wherein the characteristic of the line is a slope $\rho$ of the line.

57. The method in claim 56, wherein the frequency adjustment is related to $(1-\rho)$.

58. The node in claim 55, wherein the controller is further configured to:

determine an equation of a line that intersects the two minimum time difference values.

59. The node in claim 58, wherein the controller is further configured to:

determine the two minimum time difference values that are farthest apart.

60. The node in claim 55, wherein the controller is further configured to:

determine an optimal number of minimum values of the first time differences to be used in fitting the line.

61. The node in claim 60, wherein the controller is further configured to:

divide multiple values of the first time differences into an optimal number of time slots;

determine a minimum time difference value for each time interval; and

fit the line to intersect a minimum time difference value for each time interval.

62. The node in claim 61, wherein the controller is further configured to:

determine a minimum number of time difference values for each time interval.

63. The node in claim 55, wherein the node is a timeserver and the other node is a client node and the messages are transported over a packet-switched network.

64. The node in claim 55, wherein the communications system is a mobile communications system, the node is one of a radio network controller and a radio base station and the other node is the other of the radio network controller and the radio base station.

65. The node in claim 34, further comprising:

first timer;

wherein the controller is further configured to:

include or associate with the message a third timestamp corresponding to a time when the node sends that message back to the other node which includes or associates with each received message a fourth timestamp corresponding to a time when the other node received that message;

determine for each received message a first time difference between the corresponding first and second timestamps and a second time difference between the corresponding third and fourth timestamps, and from multiple sets of first and second time differences, determines a minimum first time difference and a minimum second time difference, and determines from one or both of the minimum first and second time differences one or both of (1) a frequency adjustment to synchronize the first and second oscillators and (2) a time adjustment to synchronize the first and second timers.

66. The node in claim 65, wherein the controller is further configured to:

determine a first line that fits the multiple sets of first time differences and a second line that fits the multiple sets of second time differences, and

from the first and second lines, determine one or both of the frequency adjustment and the time adjustment.

67. The node in claim 66, wherein the controller is further configured to:

fit the first and second lines to the first and second sets of time differences by identifying at least two minimum time difference points for each set and determining an equation of a line that intersects the two minimum delay time difference points.

68. The node in claim 67, wherein the controller is further configured to:

determine the two minimum time difference points farthest apart in each of the first and second sets.

69. The node in claim 68, wherein the controller is further configured to:

use a first slope and a first vertical axis intercept of the first line and a second slope and a second vertical axis intercept of the second line to determine the first and second minimum time differences.

70. The node in claim 69, wherein the controller is further configured to:

determine whether the first slope and the second slope have approximately the same magnitude and whether one of the first and second slopes is positive and the other is negative.